/ ***Marley Geareducer***® *Model 3600 and 4000* /

User Manual 00-198C

SPX
COOLING TECHNOLOGIES

/ Operation and Service Instructions /

Protection Against Corrosion

As shipped, a Marley Geareducer® is protected internally against corrosion with machine enamel on unmachined parts and with rust-proofing oil and grease on machined surfaces. These coatings normally protect the Geareducer against atmospheric corrosion for storage periods up to six months. However, if oil is added to the Geareducer, it will dissolve the rust-proofing grease and oil, requiring the Geareducer to be run once a week to keep a protective coating of oil on all interior machined surfaces. See **"Seasonal Shutdown"** section for information about nonoperating period maintenance.

Check Geareducer exterior yearly. Touch up with paint as required. Exposed pipe threads are coated to prevent corrosion. Touch up coating as required.

Initial Operation

The Geareducer must be filled with oil to the full oil level mark on the Geareducer case before it is placed in operation. See **Service and Lubrication** section for oil filling instructions.

Geareducers supplied with new towers include oil for the initial filling. Oil is not furnished with Geareducers supplied as spares or on replacement orders. Before operating the mechanical equipment, check to be sure the oil level is at the full mark at the Geareducer and that the external gauge placard full mark corresponds with the "Full" level in the Geareducer. Check oil lines to be sure there are no leaks.

Geareducer vent or vent line must be open to prevent failure of pinion shaft oil seal—clean when necessary. Check all gasketed joints for oil seepage. Tighten cap screws and flange bolting if necessary.

The Geareducer must be installed level and properly aligned with drive shaft and motor shaft. Refer to the **Driveshaft User Manual**.

Seasonal Shutdown one week to three months

At start of shutdown period, operate Geareducer until oil is warm—120°F (50°C)—and change the oil. See section on Service and Lubrication.

Each month drain any water condensation from the lowest point of the Geareducer and its oil system. Check the oil level and add oil if necessary. Operate the Geareducer long enough to recoat all the interior surfaces with oil.

To put back into operation, drain water condensation and check oil level. Add oil if necessary.

For longer periods of shutdown, see Marley *Manual 92-1308* **"Downtime Instruction Manual".**

Inspection Of Internal Parts

Remove the inspection cover plate from the side of the Geareducer case at each oil change. Check inside of Geareducer for cleanliness of case and internal parts. If any sludge is present, flush inside of Geareducer and connecting oil line.

Service and Lubrication

The horizontal part of the oil line must be level or slightly lower at the oil level gauge than at the Geareducer. Theoilcapacityof the Geareducer is 18½ gallons. The oil level gauge line requires approximately one gallon of additional oil. Refer to **Table 1** on page 5 for list of suggested lubricants.

Fill the Geareducer and oil line system with oil, using one of the following procedures:

Recommended procedure:

1. Install oil at the opening at the Geareducer inspection cover until it reaches the level of the "Full" mark on the Geareducer case and at the oil level gauge. See **Figures 1 and 2**. Install plug.
2. Start the fan drive and run for one minute.
3. Stop the fan drive. Allow ten minutes for oil level to stabilize and recheck oil level at the Geareducer.
4. If necessary, repeat steps 2 and 3 until stabilized oil level is at the proper level.
5. Check gauge placard location. "Full" mark on the placard must be at the same elevation as the "full" mark at the Geareducer.

Alternate procedure:

The cooling tower has an external oil gauge and drain line equipped with a three-way valve below the oil level gauge. See **Figure 1**.

1. Remove pipe plug. Turn valve control stem clockwise to open drain.
2. With Geareducer drained, the three-way valve turned clockwise, and the pipe plug removed, connect fill source (usually a hose to a pump, to the three-way valve).

   Pump oil through the hose. Check oil level occasionally by turning the valve control stem counterclockwise and allowing the oil level in the sight glass to stabilize.

   Continue filling until full level mark is reached.
3. With the oil level at the full mark turn the valve control stem counterclockwise to close the drain and open the valve to the sight glass. Remove the oil filling line and reinstall pipe plug in the three-way valve.

Maintenance of the Geareducer should be scheduled as follows:

Montly: Check oil level at least once a month using the following procedure:

Stop the fan drive. Allow ten minutes for oil level to stabilize and check oil level at the gauge. If needed, add oil to Geareducer. If oil is added, repeat steps 2 and 3 of recommended procedure until stabilized oil level is at the proper height.

Semi-Annually: Change oil at least every 6 months or 3,000 hours of operation. Refer to recommended oil change procedure.

Check the oil level placard location each time the oil is changed. The “Full” mark on the placard must be at the same elevation as the “Full” arrow on the side of the Geareducer case. See **Figures 1 and 2**.

Oil level gauge vent must be kept open. Inspect at each oil change and clean when necessary. Inspect internal parts and inside of Geareducer case at each oil change—see section on inspection of internal parts.

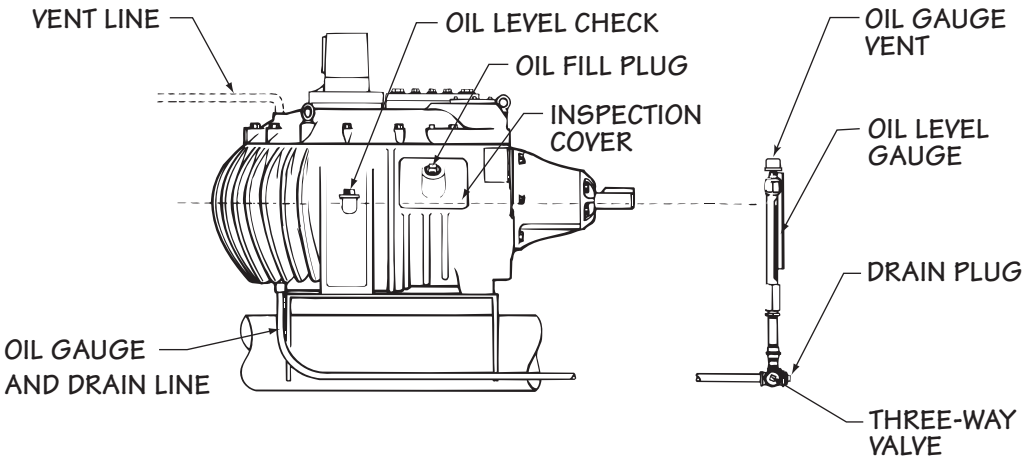

Figure 1 Service Fittings

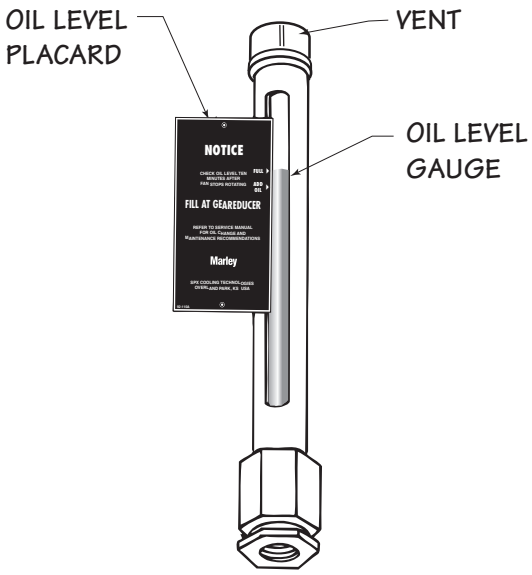

Figure 2 Oil Level Gauge Assembly

Repair and Overhaul

If your Geareducer ever needs replacement or repair, SPX Cooling Technologies recommends returning the unit to a Marley factory service center. Contact your Marley sales representative to discuss a course of action. A factory reconditioned Geareducer carries a one year warranty. The Marley Order Number on your cooling tower will be required if the Geareducer is shipped back to the factory for repair. Obtain a ***"Customer Return Material"*** tag from the Marley sales representative in you area. To find your Marley sales representative call **913.664.7400** or check the internet at **spxcooling.com**.

Major repairs require the use of a fully equipped machine shop. If you decide to repair or overhaul your Geareducer, refer to the **Field Repair** Section and Geareducer **Parts List**.

Maintenance Service	Monthly	Semi-annually	Seasonal Startup or Annually
Geareducer Drive:			
Inspect and tighten all fasteners including oil plug		**x**	**x**
Check for and repair oil leaks	**x**	**x**	**x**
Check oil level	**x**	**R**	**x**
Change oil		**R**	**R**
Make sure vent is open		**x**	**x**
Check driveshaft or coupling alignment			**x**
Inspect and tighten driveshaft or coupling fasteners			**x**
Check driveshaft or coupling bushing / flex elements for unusual wear			**x**
Lube Lines (if equipped)			
Check for oil leaks in hoses and fittings	**x**	**R**	**x**

R – Refer to instructions within this manual

Note: It is recommended at least weekly, that the general operation and condition be observed. Pay particular attention to any changes in sound or vibration that may signify a need for closer inspection.

Suggested Lubricants

The following list of lubricants—**Table 1**—is provided as reference only. These products have been recommended by their respective manufacturers as acceptable for use in a Marley spiral bevel and/or helical Geareducer for cooling tower applications. This list is not an attempt to include all the lubricants that may be satisfactory. If lubricants other than those listed are used they must not contain any additives—such as detergents or EP additives—which are adversely affected by moisture and could reduce the service life of the Geareducer. Suitability of lubricants used other than those listed rests with the customer/owner and lubricant supplier.

Manufacturer	Product
Amoco	American Industrial Oil 220
Marathon Ashland	Endurance R & O Oil 220
BP	Turbinol T-220
Century	Renolin RO 220
Citgo	Pacemaker 220
Exxon	Teresstic 220
Lubrication Engineers	Monolec 6406
Mobil	Mobil DTE Oil 220
Mobil	Mobil SHC630*
Penzoil	Pennzabell PB220 or RO220
Phillips 66	Magnus 220
Shell	Turbo T-220
Sun	Sunvis 9220
Texaco	Regal Oil R&O 220
Unocal (east)	Unax RX220
Unocal (west)	Turbine Oil 220
Valvoline	Valvaline R & O 220
	*This synthetic product may be applicable for high temperature service or extended oil life

Table 1

/ Parts List /

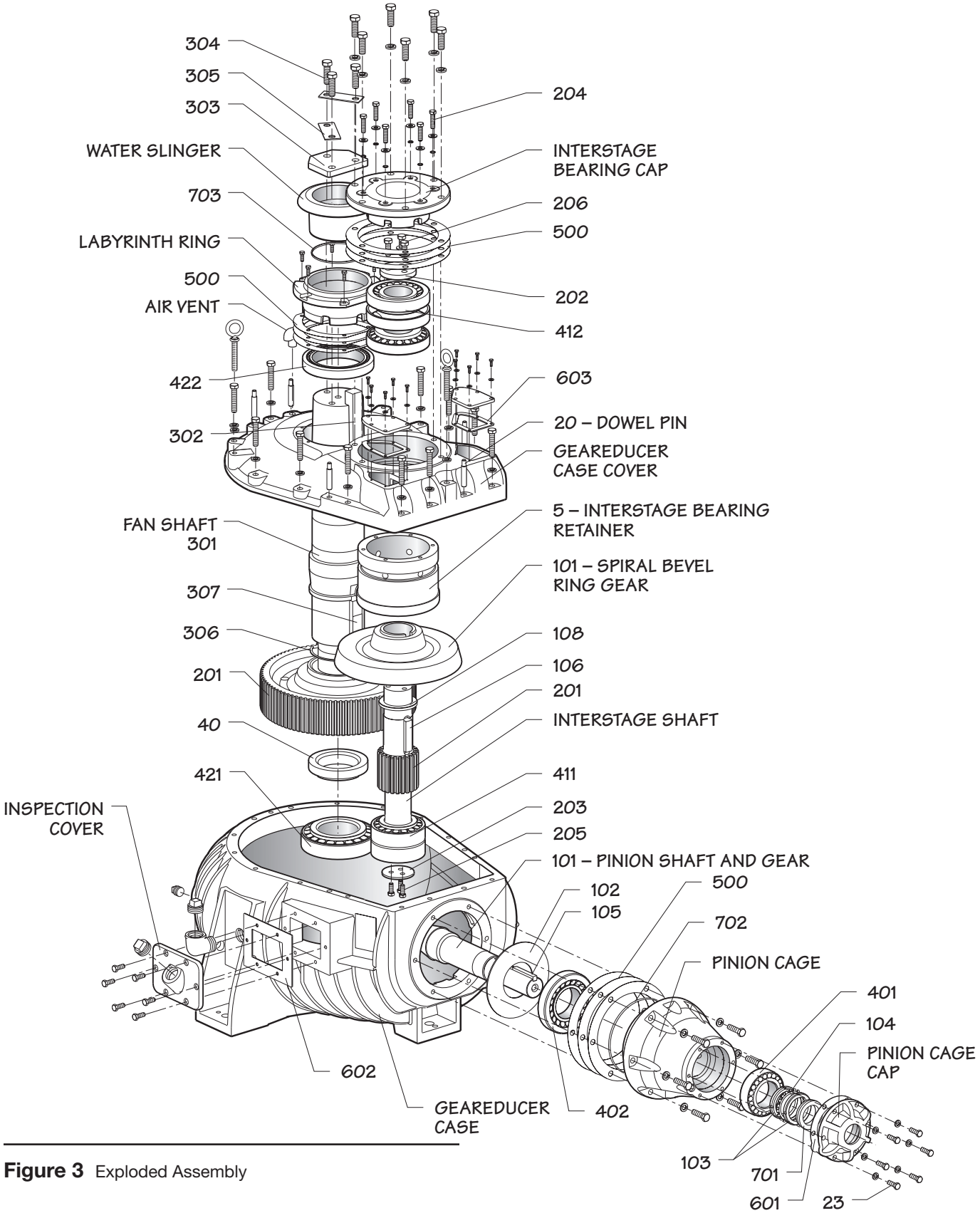

Figure 3 Exploded Assembly

/ Parts List /

1 Complete Geareducer Assembly

100 Spiral Bevel Gear Set
- **101** Set of matched spiral bevel gears including integral pinion shaft with key
  Gear ratios as follows:
  2.304 to 1 2.435 to 1 2.762 to 1
  3.158 to 1 3.167 to 1 3.944 to 1
- **102** Oil slinger
- **103** Locknuts
- **104** Lockwasher
- **105** Pinion shaft key
- **106** Interstage shaft key
- **108** Ring gear spacer (2.304 and 2.435 gear sets only)

200 Helical Gear Set
- **201** Set of matched helical gears including interstage shaft and special key
  Gear ratios as follows:
  4.18 to 1 4.70 to 1 5.00 to 1
- **202** Top interstage bearing retainer disc
- **203** Bottom interstage bearing retainer disc
- **204** Place bolts and washers
- **205** Place bolts and washers
- **206** Place bolts and washers

300 Fan Shaft Assembly
- **301** Fan shaft
- **302** Key
- **303** Fan hub retainer
- **304** Cap screw
- **305** Locking plates
- **306** Retainer ring
- **307** Key

400 Pinion Shaft Bearing Set
- **401** Tail, tapered roller bearing
- **402** Head, tapered roller bearing

410 Interstage Bearing Set
- **411** Lower, double row, tapered roller bearing. Matched assembly with cone spacer
- **412** Upper, double row, tapered roller bearing. Matched assembly with cup spacer

420 Fan Shaft Bearing Set
- **421** Lower tapered roller bearing
- **422** Upper tapered roller bearing

500 Shim set
- **501-502-503** Pinion shaft shims
- **504-505-506** Interstage shaft shims
- **507-508-509** Fan shaft shims

600 Gasket Set
- **601** Pinion cage gasket
- **602** Inspection cover gasket
- **603** Oil trough gasket

700 O-Rings Set.
- **702** Pinion cage O-ring, 9¾" ID × 10″ OD × ⅛"
- **703** Water slinger O-ring, 6½" ID × 6¾" OD × ⅛"

701 Pinion Shaft Oil Seal

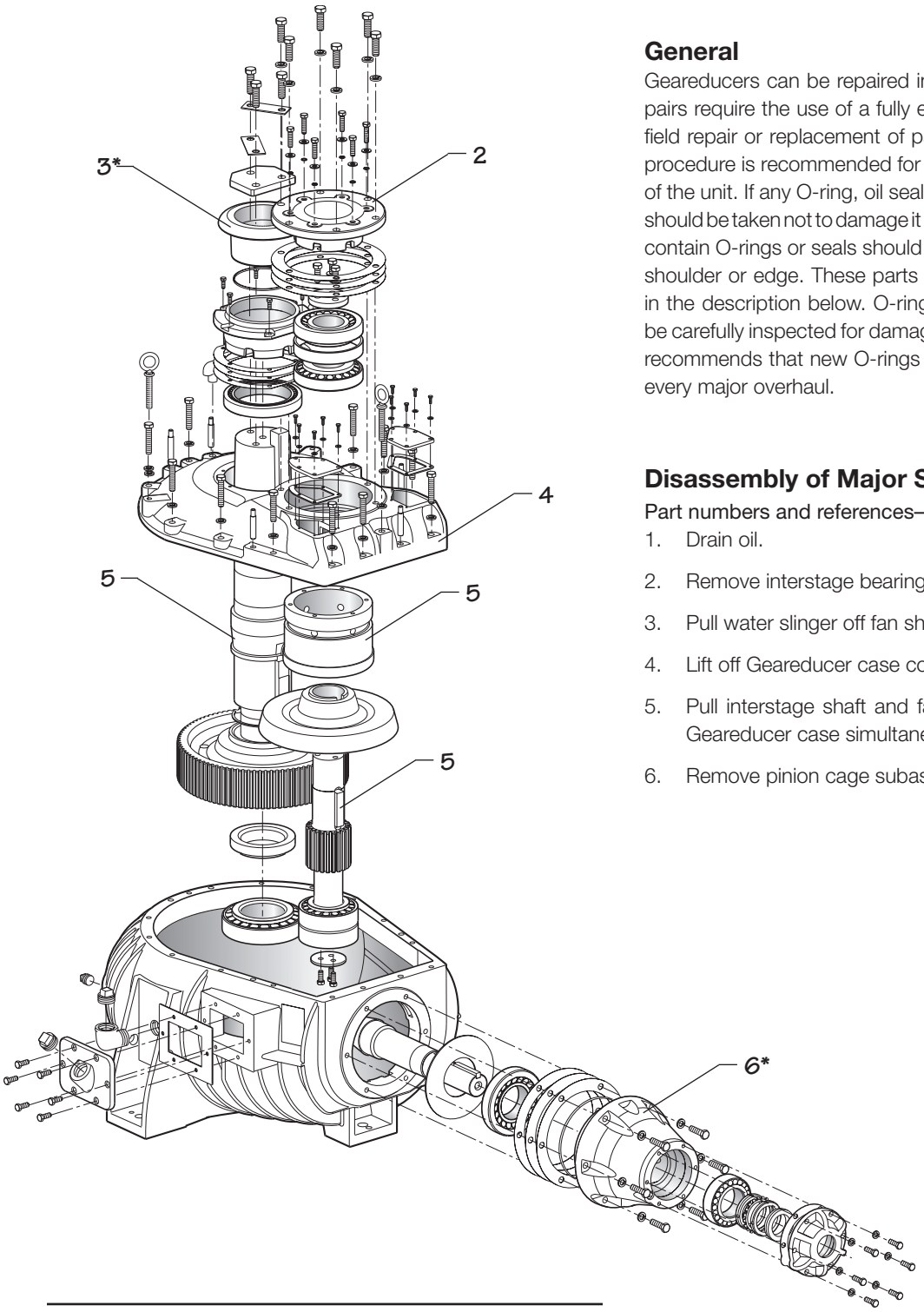

Figure 4 Disassembly of Major Subassemblies

General

Geareducers can be repaired in the field—however, major repairs require the use of a fully equipped machine shop. When field repair or replacement of parts is necessary, the following procedure is recommended for the disassembly and assembly of the unit. If any O-ring, oil seal or gasket is to be reused, care should be taken not to damage it during disassembly. Parts which contain O-rings or seals should not be jerked or twisted past a shoulder or edge. These parts are marked with an asterisk (*) in the description below. O-rings, oil seal and gaskets should be carefully inspected for damage before being reinstalled. SPX recommends that new O-rings and oil seal be installed during every major overhaul.

Disassembly of Major Subassemblies

Part numbers and references—refer to ***Figures 3 and 4***.

1. Drain oil.
2. Remove interstage bearing cap.
3. Pull water slinger off fan shaft.*
4. Lift off Geareducer case cover.
5. Pull interstage shaft and fan shaft subassemblies out of Geareducer case simultaneously.
6. Remove pinion cage subassembly.*

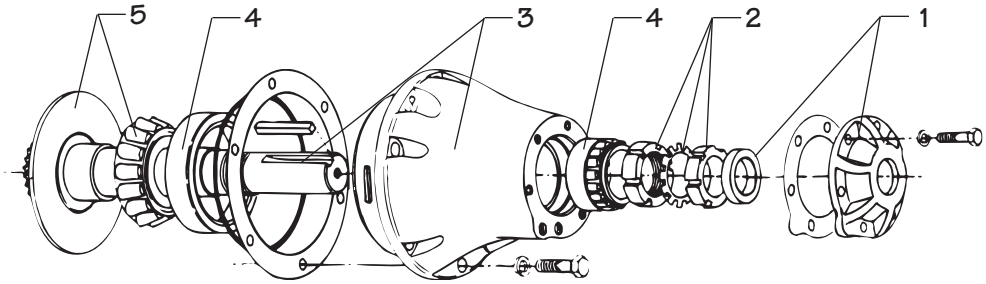

Figure 5 Disassembly of Pinion Cage

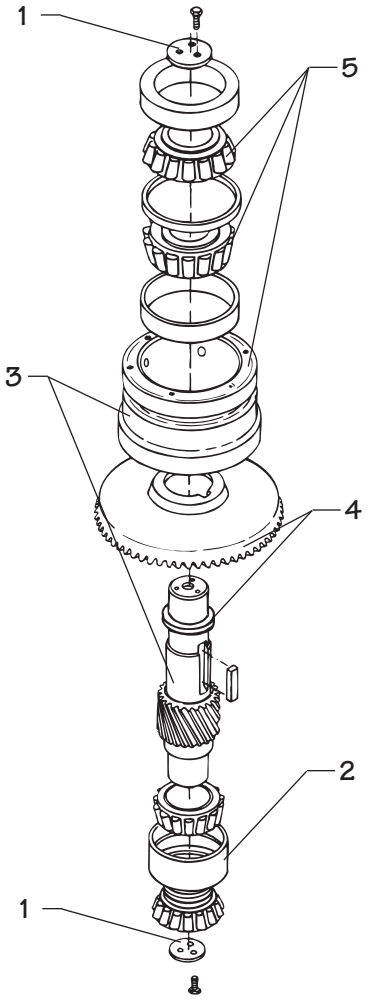

Figure 6 Disassembly of Interstage

Disassembly of Pinion Cage

Part numbers and references—refer to ***Figures 3 and 5***.

1. Remove pinion cage cap and rotating portion of oil seal (**701**).
2. Remove locknuts (**103**) and washer (**104**) from pinion shaft.
3. Press pinion shaft with head bearing cone (**402**) out of pinion cage. This will free cone of tail bearing (**401**).
4. Remove bearing cups from pinion cage.
5. If bearing cone on head of pinion shaft is to be replaced, it will be necessary to press off oil slinger (**102**) and bearing cone at the same time.

Disassembly of Interstage

Part numbers and references—refer to ***Figures 3 and 6***.

1. Remove top and bottom interstage bearing discs (**202** and **203**).
2. Pull bottom bearing (**411**), two cones with spacer and one cup from shaft.
3. Push shaft out of upper bearing (**412**) and retainer.
4. Remove spiral bevel ring gear and spacer (spacer used on 2.304 and 2.435 gear sets only) from shaft.
5. Pull upper bearings from top interstage retainer (**5**).

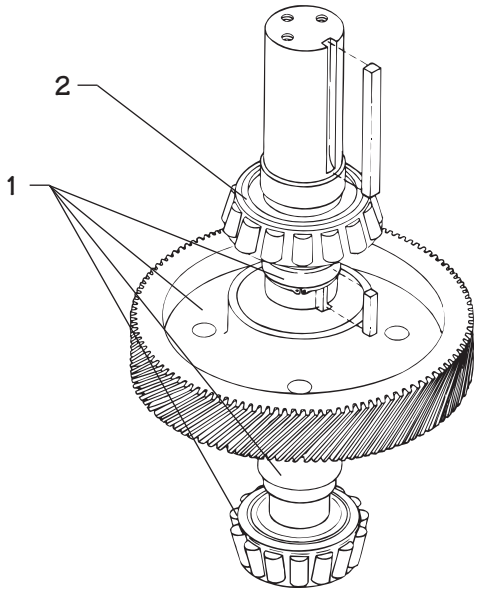

Figure 7 Disassembly of Fan Shaft

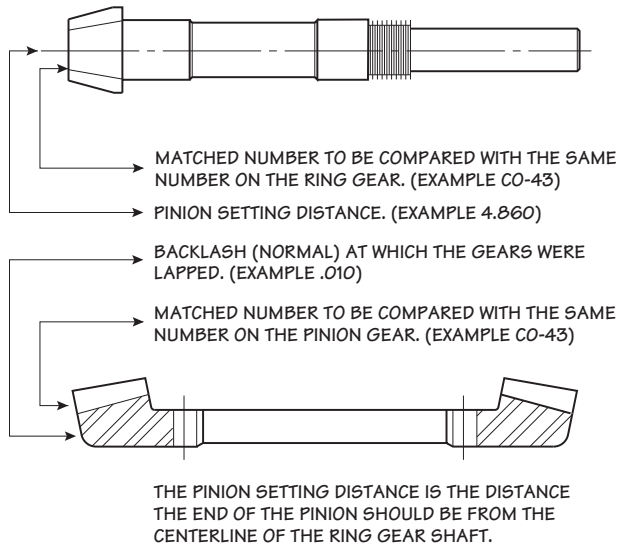
MATCHED NUMBER TO BE COMPARED WITH THE SAME NUMBER ON THE RING GEAR. (EXAMPLE CO-43)
PINION SETTING DISTANCE. (EXAMPLE 4.860)
BACKLASH (NORMAL) AT WHICH THE GEARS WERE LAPPED. (EXAMPLE .010)
MATCHED NUMBER TO BE COMPARED WITH THE SAME NUMBER ON THE PINION GEAR. (EXAMPLE CO-43)
THE PINION SETTING DISTANCE IS THE DISTANCE THE END OF THE PINION SHOULD BE FROM THE CENTERLINE OF THE RING GEAR SHAFT.

Figure 8 Gear Match Numbers and Setting Data

Disassembly of Fan Shaft

Part numbers and references—refer to ***Figures 3 and 7***.

1. Press helical ring gear (**201**), lower fan shaft spacer (**40**) and lower cone (**421**) from shaft. Remove key spacer ring.
2. Remove upper bearing cone (**422**).
3. Remove upper fan shaft bearing cup (**422**) from case cover (not illustrated).
4. Remove lower fan shaft bearing cup (**421**) from case (not illustrated).

Assembly of Geareducer

Gear Match Numbers and Setting Data

Before assembling a new pinion gear in the pinion cage check match numbers on pinion gear and spiral bevel ring gear to be certain that they are a matched set. Gears are lapped in matched sets at the factory and should not be separated. Numbers are etched on both the pinion and ring gear as illustrated in **Figure 8**.

Pinion Cage Assembly

Part numbers and references—refer to ***Figures 3 and 9***.

1. Press oil slinger (**102**) onto pinion shaft.
2. Install pinion head bearing cone (**402**) on pinion shaft.
3. Press pinion head bearing cup (**402**) into pinion cage.
4. Press pinion tail bearing cup (**401**) into pinion cage.
5. Lower pinion cage over pinion shaft until head bearing cone (**402**) mates with cup.
6. Press tail bearing cone (**401**) onto pinion shaft.

   a–Lock with lock nuts (**103**) and lockwasher (**104**) to provide bearing preload of 10 to 18 in·lb$_f$ (1130-2034 mN·m) resistance to rotation of pinion shaft.

   b–Crimp ears of lockwasher (**104**) to locknuts after obtaining prober preload.
7. Slide oil seal (**701**) onto pinion shaft.
8. Assemble pinion cage cap to pinion cage with gasket or RTV (**601**). Tighten bolts (**23**) to 55 ft·lb$_f$ (75 N·m) torque.

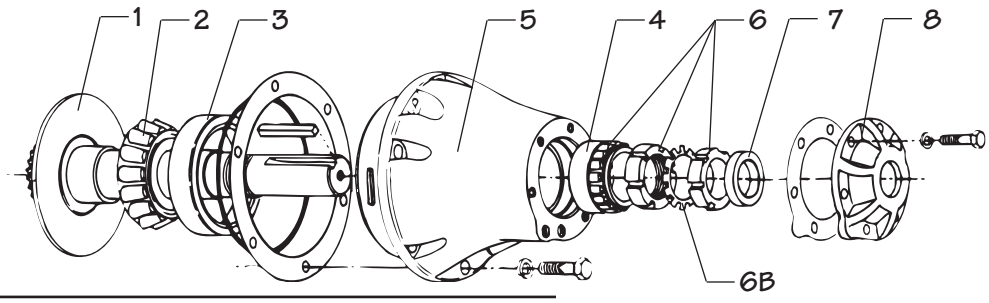

Figure 9 Pinion Cage Assembly

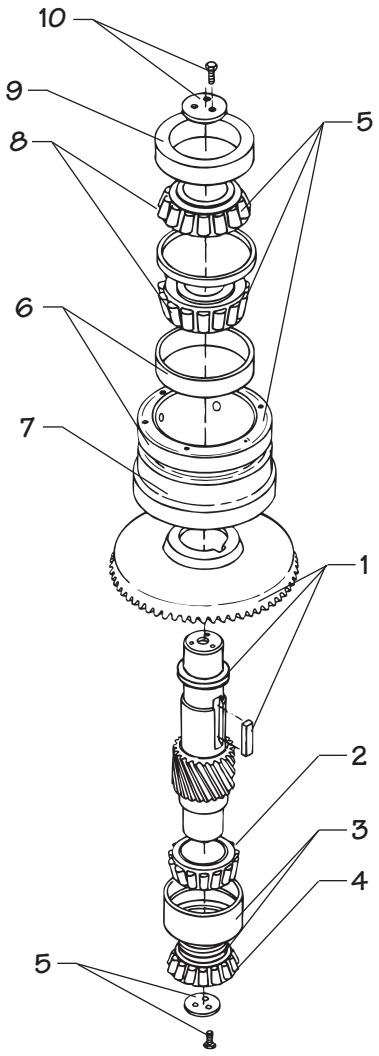

Figure 10 Interstage Assembly

Interstage Assembly

Part numbers and references—refer to ***Figures 3 and 10***.

1. Install spiral bevel ring gear spacer (spacer used on 2.304 and 2.435 gear sets only) against top of helical pinion. Install key (**106**) and spiral bevel ring gear on interstage shaft.
2. Press top cone of bottom interstage bearing (**411**) onto interstage shaft.
3. Install double cup and spacer of bottom interstage bearing (**411**).
4. Press bottom cone into place.
5. Install retainer (**203**) with bolts. Tighten to 55 ft·lb$_f$ (75 N·m) torque.
6. Press lower cup of upper interstage bearing into retainer (**5**).
7. Lower retainer (**5**) over interstage shaft.
8. Press upper bearing cones (**412**) onto shaft.
9. Press upper cup (**412**) and spacer into retainer (**5**).
10. Install disc (**202**) with place bolts. Tighten to 150 ft·lb$_f$ (204 N·m) torque.

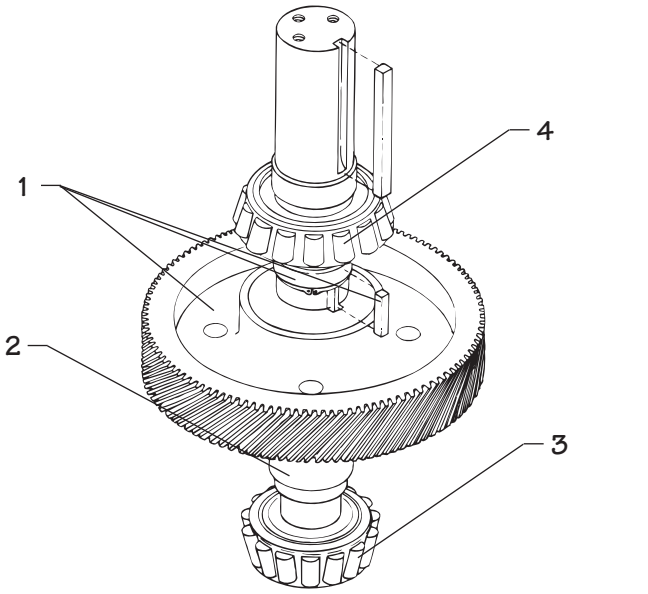

Figure 11 Fan Shaft Assembly

Fan Shaft Assembly

Part numbers and references—refer to ***Figures 3 and 11***.

1. Install the key spacer ring. Install key and press helical gear (**201**) on fan shaft.
2. Press lower bearing spacer (**40**) on fan shaft.
3. Press bottom bearing cone (**421**) onto fan shaft.
4. Press upper bearing cone (**422**) on fan shaft
5. Install lower fan shaft bearing cup (**421**) into Geareducer case (not illustrated).
6. Install upper fan shaft bearing cup (**422**) into Geareducer case cover (not illustrated).

Final Assembly

Part numbers and references—refer to ***Figure 12***.

1. Install O-ring (**702**) onto pinion cage subassembly.
2. Bolt pinion cage subassembly to case using proper number of shims to give indicated pinion setting distance which is etched on front face of pinion gear. See **Figure 8**. Tighten to 75 ft·lb$_f$ (102 N·m) torque.
3. Lower fan shaft and interstage shaft subassemblies into case simultaneously. Engage marked spiral bevel ring gear teeth with marked spiral bevel pinion tooth. The gear and pinion are match-marked when lapped and must be assembled the same way. The ring gear has the end of two teeth marked "X" and the pinion has one tooth so marked— the gears should be engaged with the X-marked pinion tooth between those marked on the ring gear. Match mark location can be checked through the inspection opening.
4. Apply a coat of Permatex® Form-a-Gasket No. 2 to surface of Geareducer case which mates with case cover. Lower case cover subassembly onto case, piloting both shaft subassemblies into their respective bores.
5. Install dowel pins (**20**) to align bearing bores. Fasten case cover to case with cap screws tightening to 75 ft·lb$_f$ (102 N·m) torque.
6. Position top interstage cap shims and install interstage bearing cap with place bolts tightening to 85-90 ft·lb$_f$ (116-122 N·m) torque.
7. Adjust shims to give proper backlash—.007–.009″ normal (.178–.228mm)—between spiral bevel gears. See **Gear Setting Procedure,** page 14.
8. Fan shaft bearing must be preloaded to .001–.003″ (.025–.076mm) in the following manner:

   a–Install labyrinth ring in case-cover initially with a quantity of shims between cover and labyrinth ring to insure that axial bearing end play exists. Tighten labyrinth ring cap screws to 35 ft·lb$_f$ (48 N·m) torque.

   b–Mount a dial indicator to measure axial movement of fan shaft. Support indicator stand on the cover or interstage cap adjacent to fan shaft and position indicator to read on machined top surface of fan shaft

   c–Rotate the fan shaft slowly in one direction until all downward movement stops. Rotation is necessary to align the bearing rollers and seat roller ends on cone lip. Record the dial indicator reading or zero the indicator.

   d–Move shaft in the opposite axial direction by attaching to the shaft with a swivel joint and hoist and lifting on shaft. Lifting force should be 800 lb (363 kg) to sufficiently overcome the weight of the fan shaft assembly. Rotate the shaft slowly in one direction until all axial movement stops. Record the dial indicator reading.

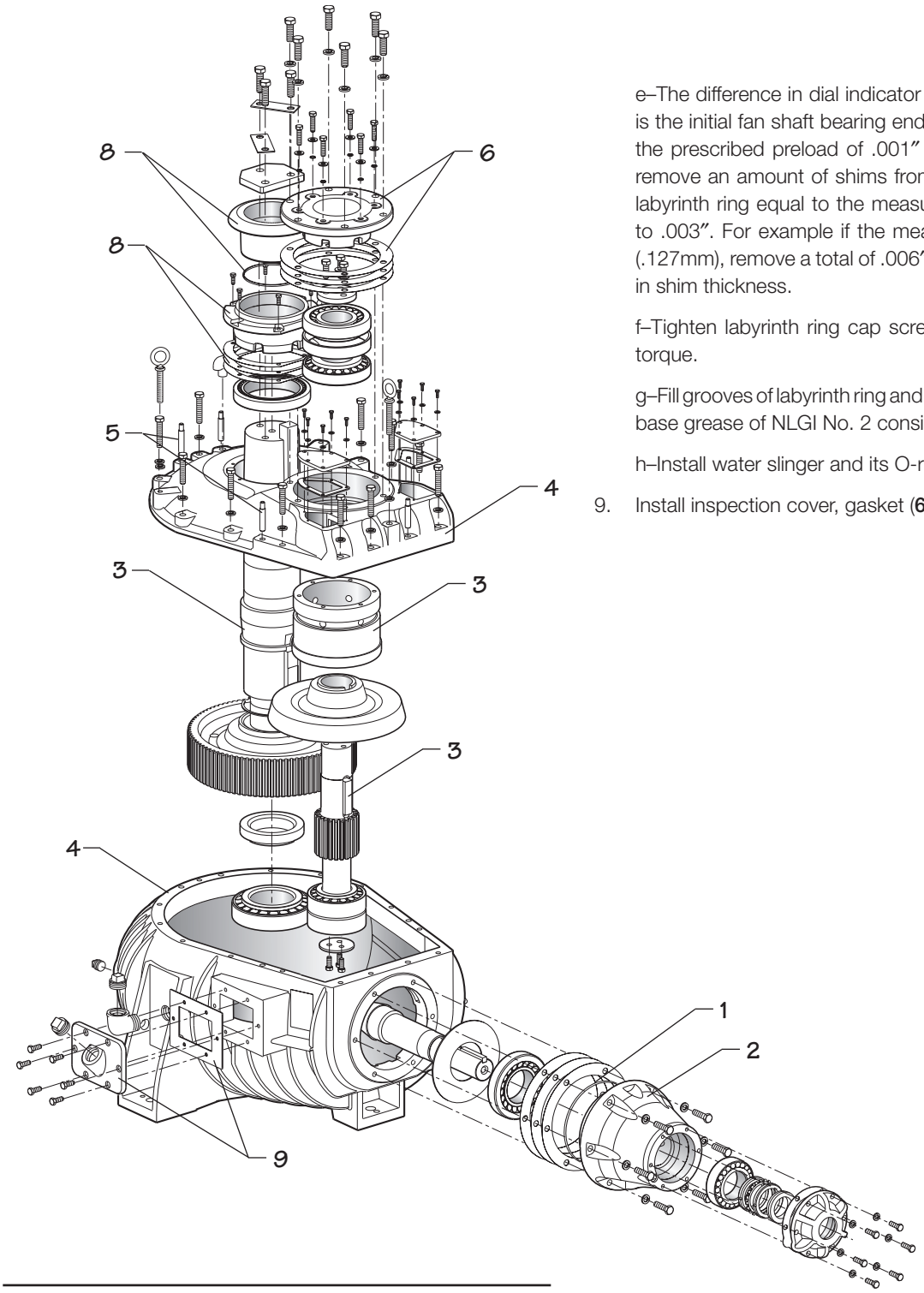

Figure 12 **Final Assembly**

e–The difference in dial indicator readings (steps c and d) is the initial fan shaft bearing end play. In order to achieve the prescribed preload of .001″ to .003″ (.025–.076mm) remove an amount of shims from between the case and labyrinth ring equal to the measured end play plus .001″ to .003″. For example if the measured end play is .005″ (.127mm), remove a total of .006″ to .008″ (.152–.203mm) in shim thickness.

f–Tighten labyrinth ring cap screws to 35 ft·lb$_f$ (48 N·m) torque.

g–Fill grooves of labyrinth ring and water slinger with lithium-base grease of NLGI No. 2 consistency.

h–Install water slinger and its O-ring (**703**) on fan shaft.

9. Install inspection cover, gasket (**602**), and pipe plugs.

Gear Setting Procedure

Part numbers and references—refer to ***Figures 3 and 13***.
The proper mounting of the gear set is essential to obtain long life and smooth operation of the gears. The pinion cage position adjustment is obtained by shims under the flange of the pinion cage. Shims are placed under the top interstage bearing cap to adjust ring gear position. The gear setting may require several attempts before obtaining the proper backlash and tooth contact pattern.

The gear and pinion are match-marked when lapped and must be assembled the same way. The ring gear has the end of two teeth marked "X" and the pinion has one tooth so marked—the gears should be engaged with the X-marked pinion tooth between those marked on the ring gear. Match marks can be checked through the inspection opening.

With the marked teeth of the gear engaged, check backlash with dial indicator—see **Figure 13**. The indicator can be installed through the inspection cover opening. Change shims under top interstage bearing cap until backlash is between .007–.009″(.178–.228mm) normal to ring gear tooth.

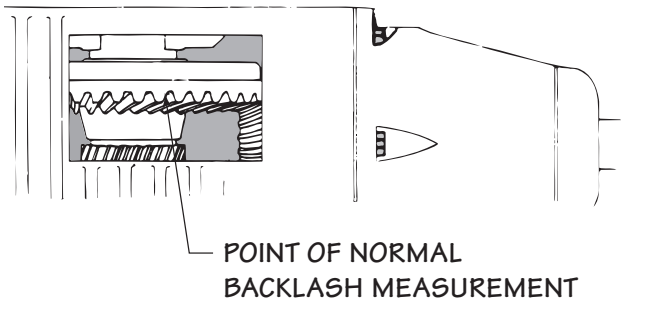

Figure 13 Gear Backlash Measurement

With gears adjusted for proper backlash, blue (Prussian Blue in oil) the gear teeth. Drive the pinion by turning ring gear in both directions for several revolutions. Observe the contact pattern on both gears on both sides of the teeth. The contact pattern should be as shown in **Figure 14**.

If correct tooth contact pattern is not obtained on first attempt, refer to **Figure 14**—these illustrations show the two cases of “out-of- position contact” in the extreme. One of the remedies indicated will correct the out-of-position contact—compare the tooth contact pattern with the illustrations in **Figure 14** and choose the required remedy.

When proper tooth contact has been obtained, recheck the backlash at marked teeth. If it is within the desired range—.007–.009″ (.178–.228mm), check backlash with dial indicator at two additional points 120° apart (with inspection cover removed), and as shown in **Figure 13**. All backlash readings must be within the specified range. If backlash is not within the limits, adjust ring gear height with shims until it is, checking again as described.

The tooth contact pattern should again be checked to determine if adjusting the backlash has produced any shift. If it has shifted, move the pinion in the opposite direction the gear was moved with respect to the cone center. If the gear mounting distance is reduced, increase pinion setting distance, and vice versa, (see **Figure 9**) an amount proportional to the number of teeth in the respective members. For example: on a 10 to 1 gear set, if the ring gear was moved .010″ (.25mm) , the pinion should be moved 0.001″ (.025mm). This would be necessary only if the contact pattern had visually shifted due to movement of the ring gear while adjusting backlash.

When setting a used set of gears, follow the method outlined above. However, depending upon the amount of wear, it may be necessary to set the gears up with slightly greater backlash in order to obtain proper contact. ***Proper tooth contact pattern is the most important factor for correct installation.***

Should a condition be encountered where correct contact cannot be obtained as described in this manual, the Geareducer should be returned to Marley in exchange for a factory reconditioned unit.

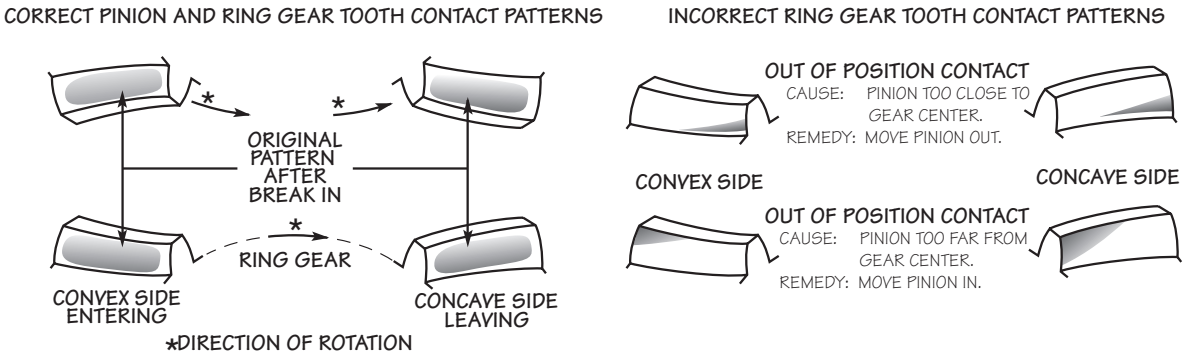
CORRECT PINION AND RING GEAR TOOTH CONTACT PATTERNS
INCORRECT RING GEAR TOOTH CONTACT PATTERNS
ORIGINAL PATTERN AFTER BREAK IN
RING GEAR
CONVEX SIDE ENTERING
CONCAVE SIDE LEAVING
*DIRECTION OF ROTATION
OUT OF POSITION CONTACT
CAUSE: PINION TOO CLOSE TO GEAR CENTER.
REMEDY: MOVE PINION OUT.
CONVEX SIDE
CONCAVE SIDE
OUT OF POSITION CONTACT
CAUSE: PINION TOO FAR FROM GEAR CENTER.
REMEDY: MOVE PINION IN.

Figure 14 Spiral Bevel Gear Tooth Pattern

SPX®

COOLING TECHNOLOGIES

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